

From the Lab to the Market to Standards The Role of California Energy Policy

**California Lighting Technology Center
1 Nov. 2006**

**Arthur H. Rosenfeld, Commissioner
California Energy Commission**

(916) 654-4930

ARosenfe@Energy.State.CA.US

<http://www.energy.ca.gov/commission/commissioners/rosenfeld.html>

Or just Google “Art Rosenfeld”

Start =Google, 30 min.

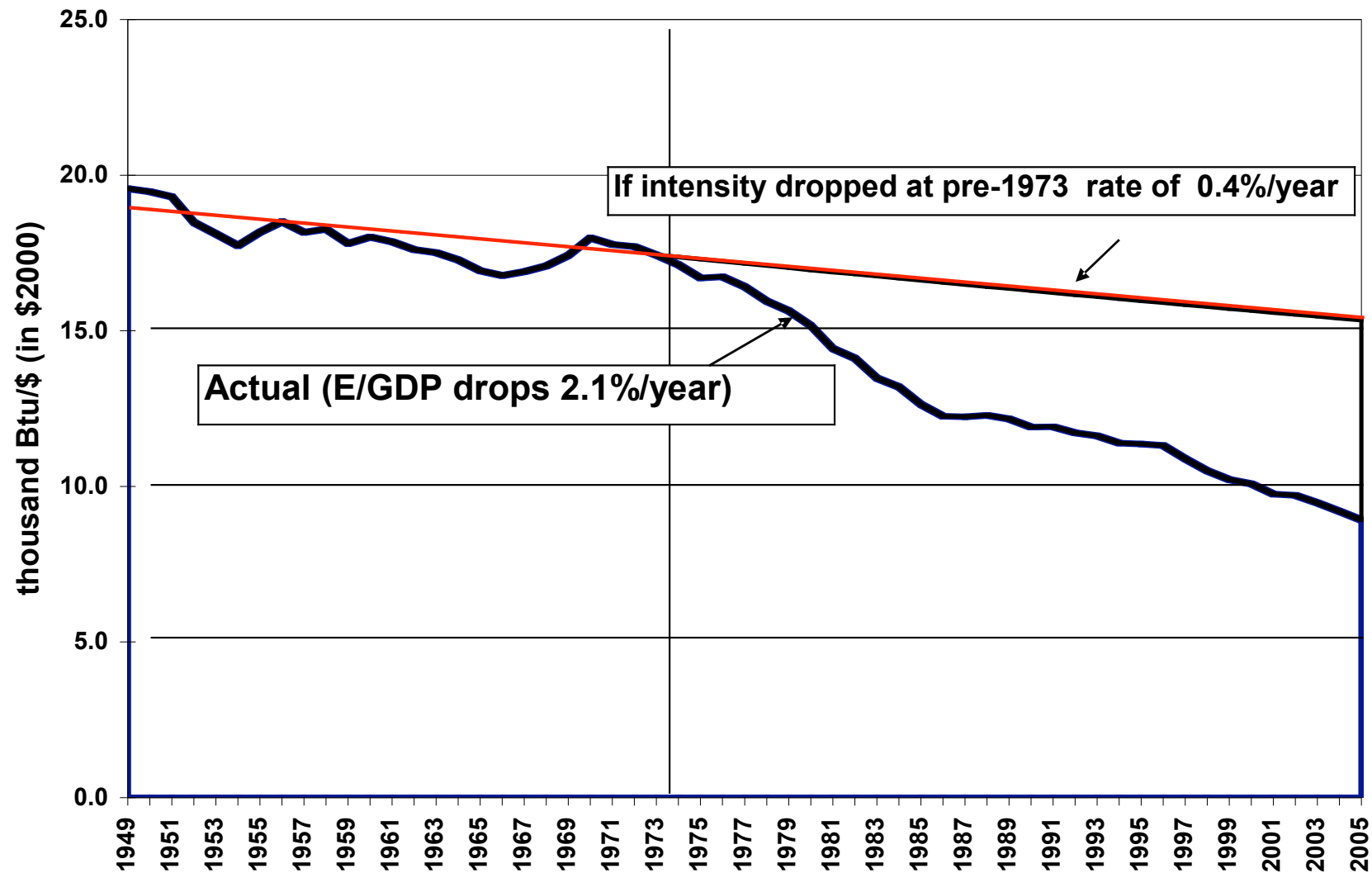
1949

Rosenfeld

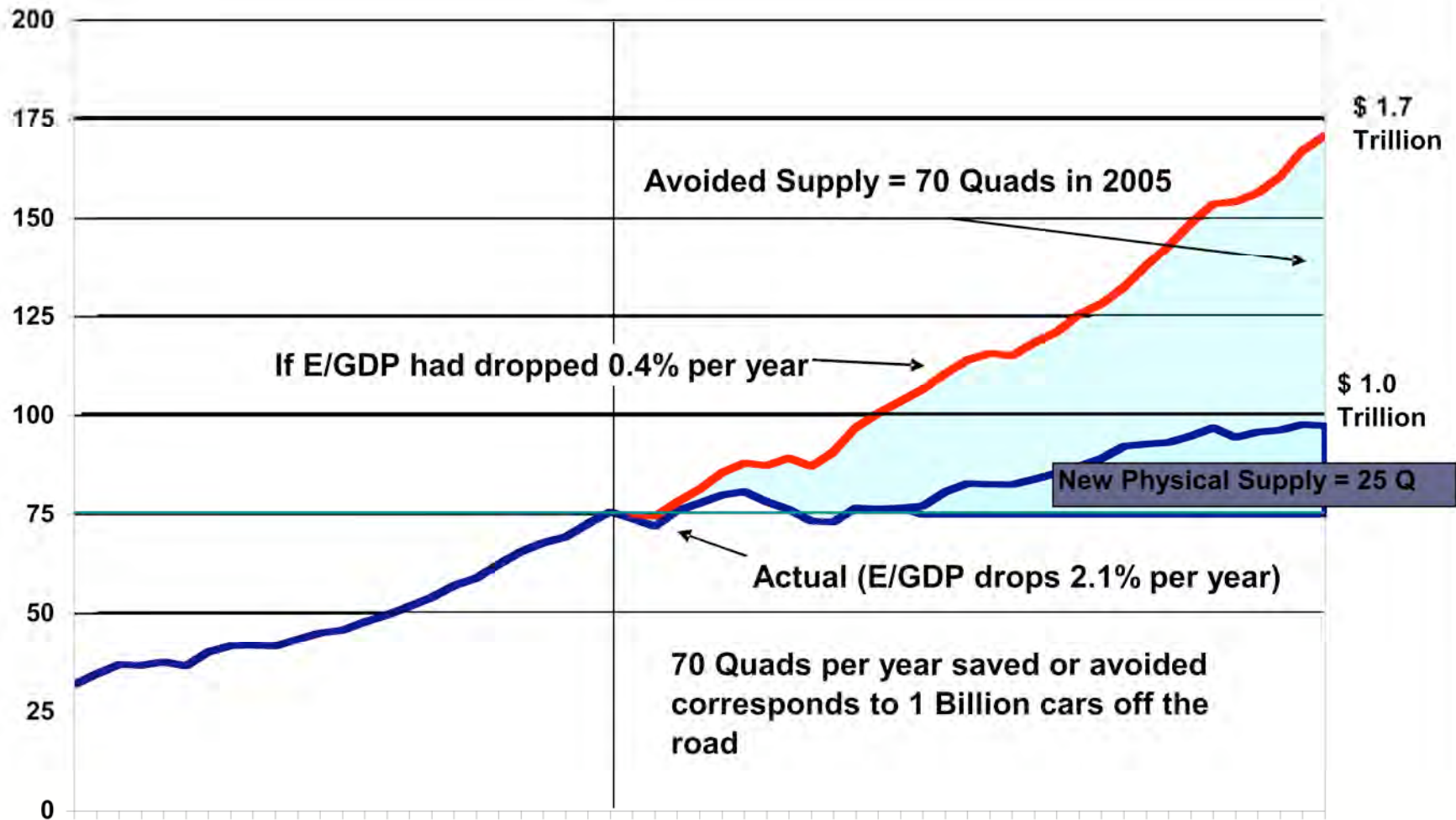
Nuclear Physics

A Course Given by **ENRICO FERMI**
at the University of Chicago. Notes Compiled by
Jay Orear, A. H. Rosenfeld, and R. A. Schluter

Energy Intensity in the United States 1949 - 2005



Energy Consumption in the United States 1949 - 2005



How Much of The Savings Come from Efficiency?

- ◆ Easiest to tease out is cars
 - In the early 1970s, only 14 miles per gallons
 - Now about 21 miles per gallon
 - If still at 14 mpg, we'd consume **75 billion gallons more** and pay **\$225 Billion more** at 2006 prices
 - But we still pay **\$450 Billion per year**
 - If California wins the “Schwarzenegger-Pavley” suit, and it is implemented nationwide, we'll save **another \$150 Billion per year**
- ◆ Commercial Aviation improvements save another **\$50 Billion per year**
- ◆ Appliances and Buildings are more complex
 - We must sort out true efficiency gains vs. structural changes (from smokestack to service economy).

How Much of The Savings Come from Efficiency (cont'd)?

- ◆ Some examples of estimated savings in 2006 based on 1974 efficiencies minus 2006 efficiencies

	Billion \$
Space Heating	40
Air Conditioning	30
Refrigerators	15
Fluorescent Tube Lamps	5
Compact Fluorescent Lamps	5
Total	95

- ◆ Beginning in 2007 in California, reduction of “vampire” or stand-by losses
 - This will save \$10 Billion when finally implemented, nation-wide
- ◆ Out of a total **\$700 Billion**, a crude summary is that 1/3 is structural, 1/3 is transportation, and 1/3 is buildings and industry.

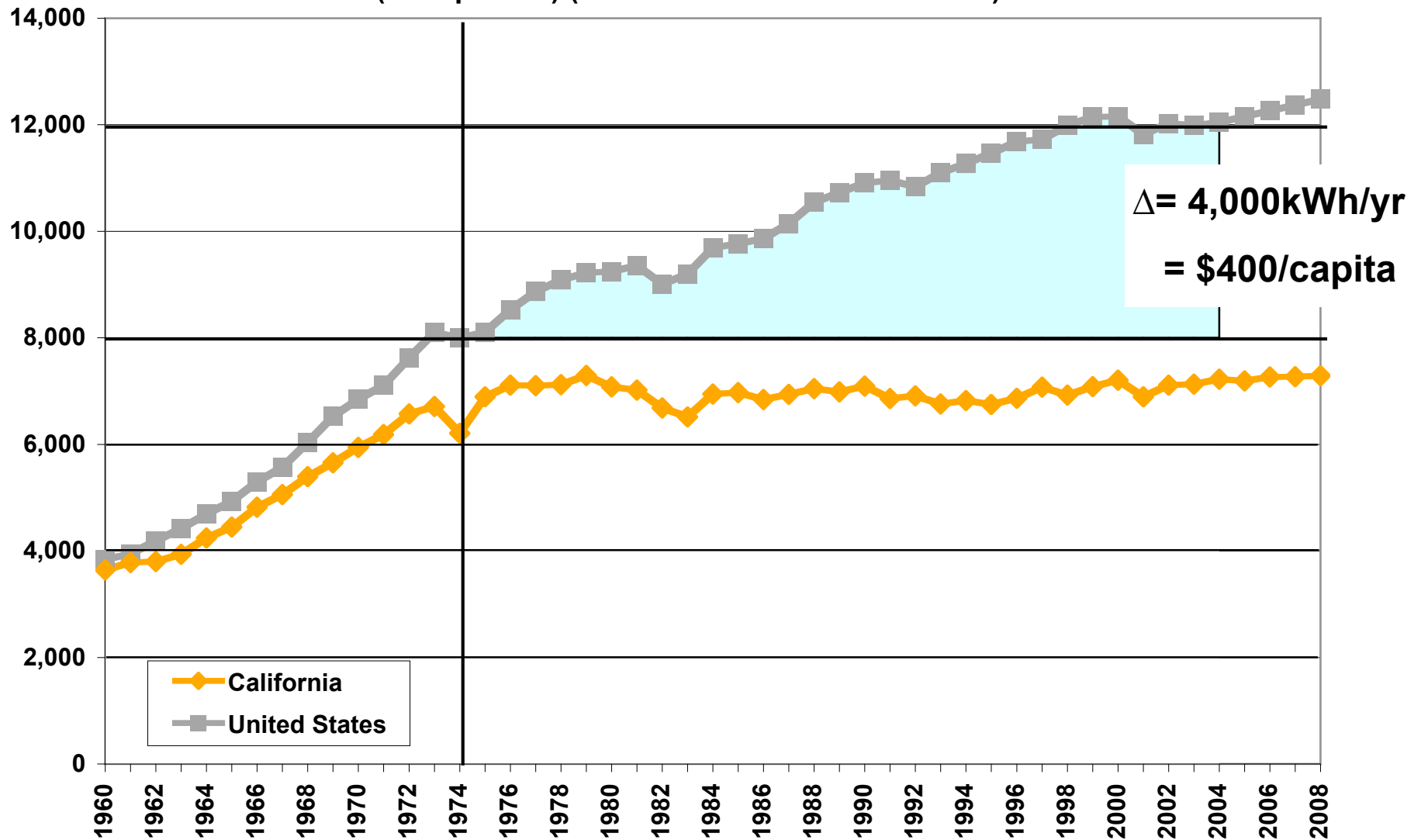
A supporting analysis on the topic of efficiency from Vice-President Dick Cheney

- ◆ “Had energy use kept pace with economic growth, the nation would have consumed 171 quadrillion British thermal units (Btus) last year instead of 99 quadrillion Btus”
- ◆ “About a third to a half of these savings resulted from shifts in the economy. The other half to two-thirds resulted from greater energy efficiency”

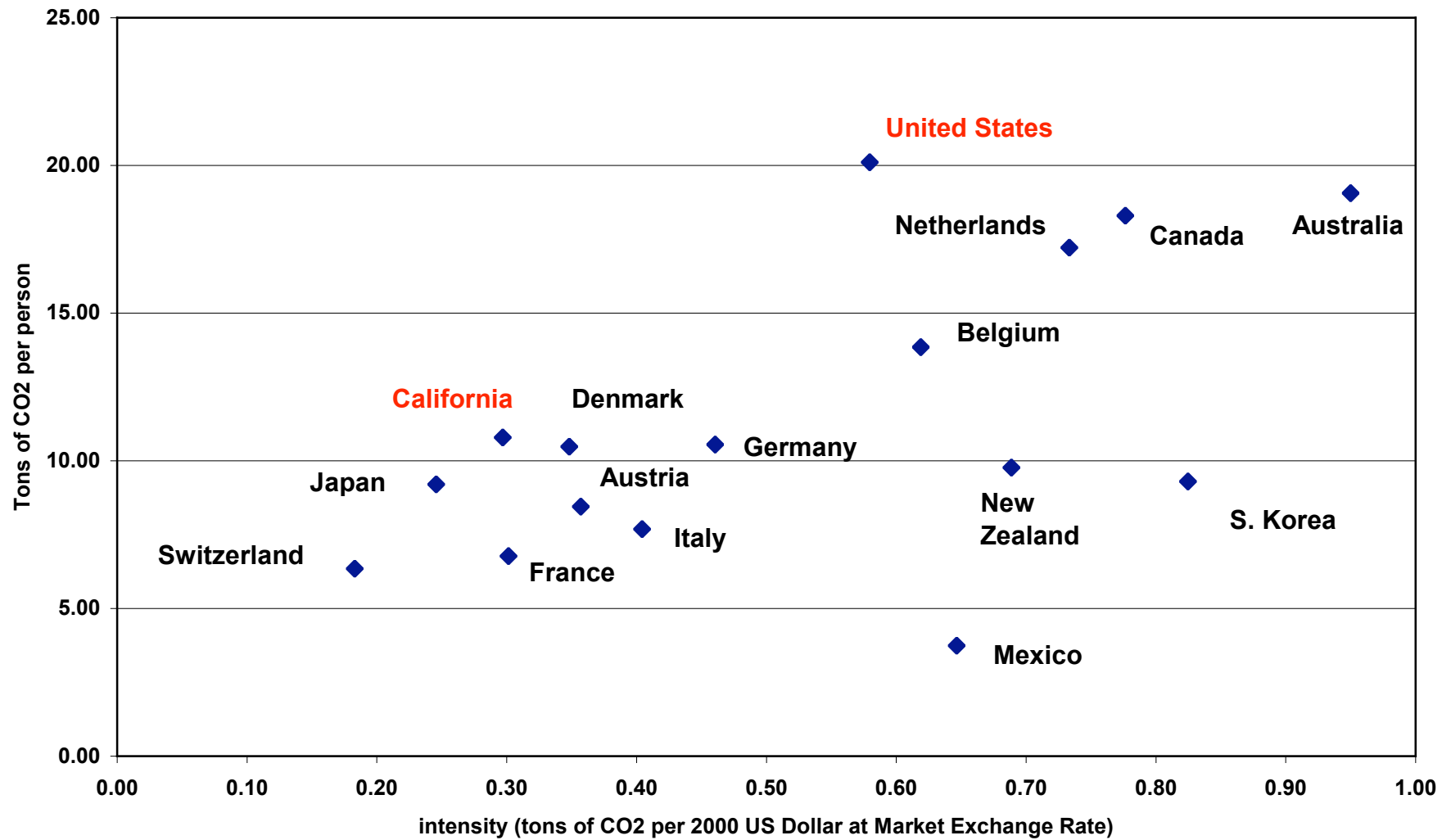
Source: National Energy Policy: Report of the National Energy Policy Development Group, Dick Cheney, et. al., page 1-4, May 2001

Cheney could have noted that 72 quads/year saved in the US alone, would fuel one Billion cars, compared to a world car count of only 600 Million

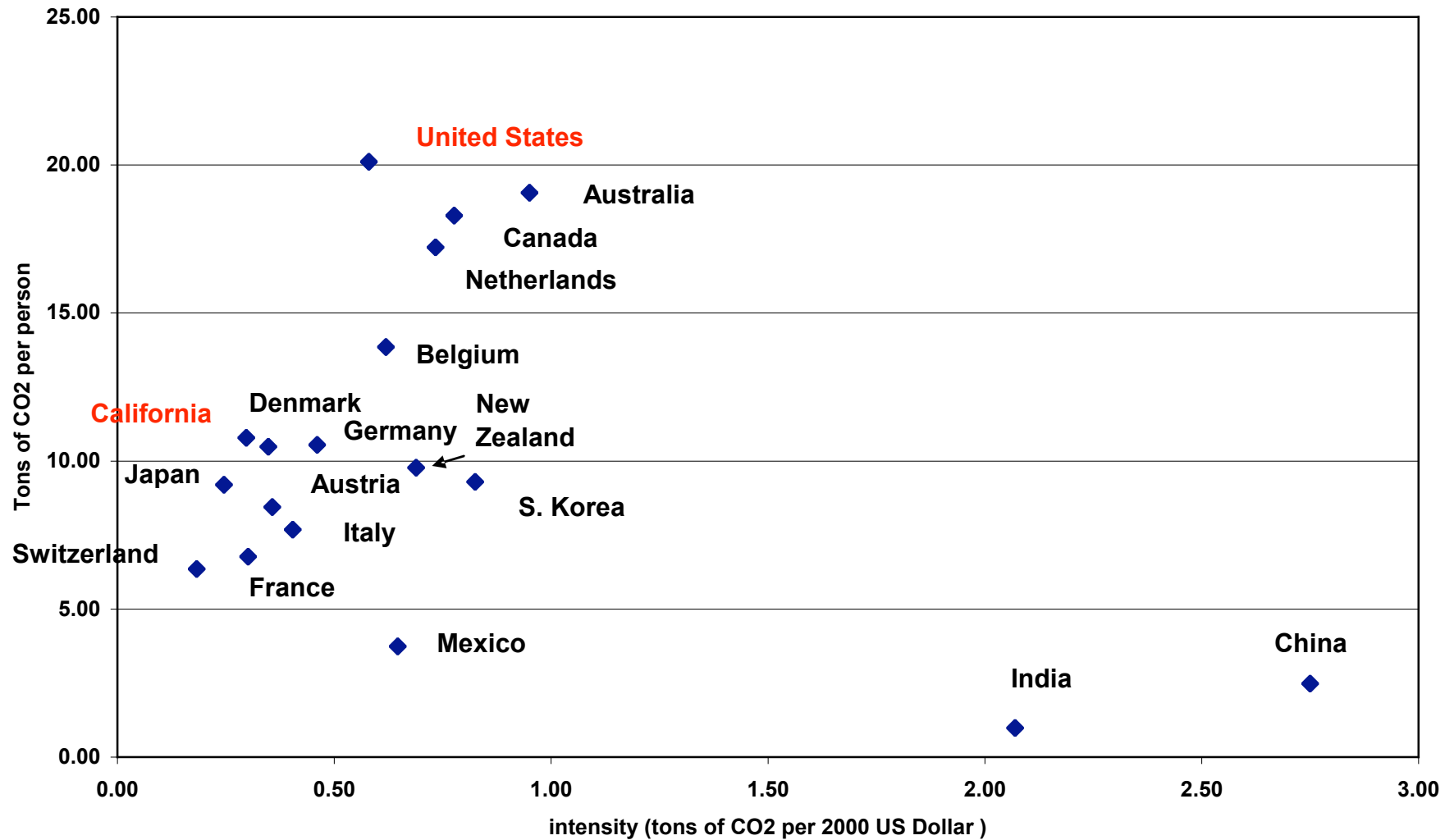
Per Capita Electricity Sales (not including self-generation)
(kWh/person) (2005 to 2008 are forecast data)



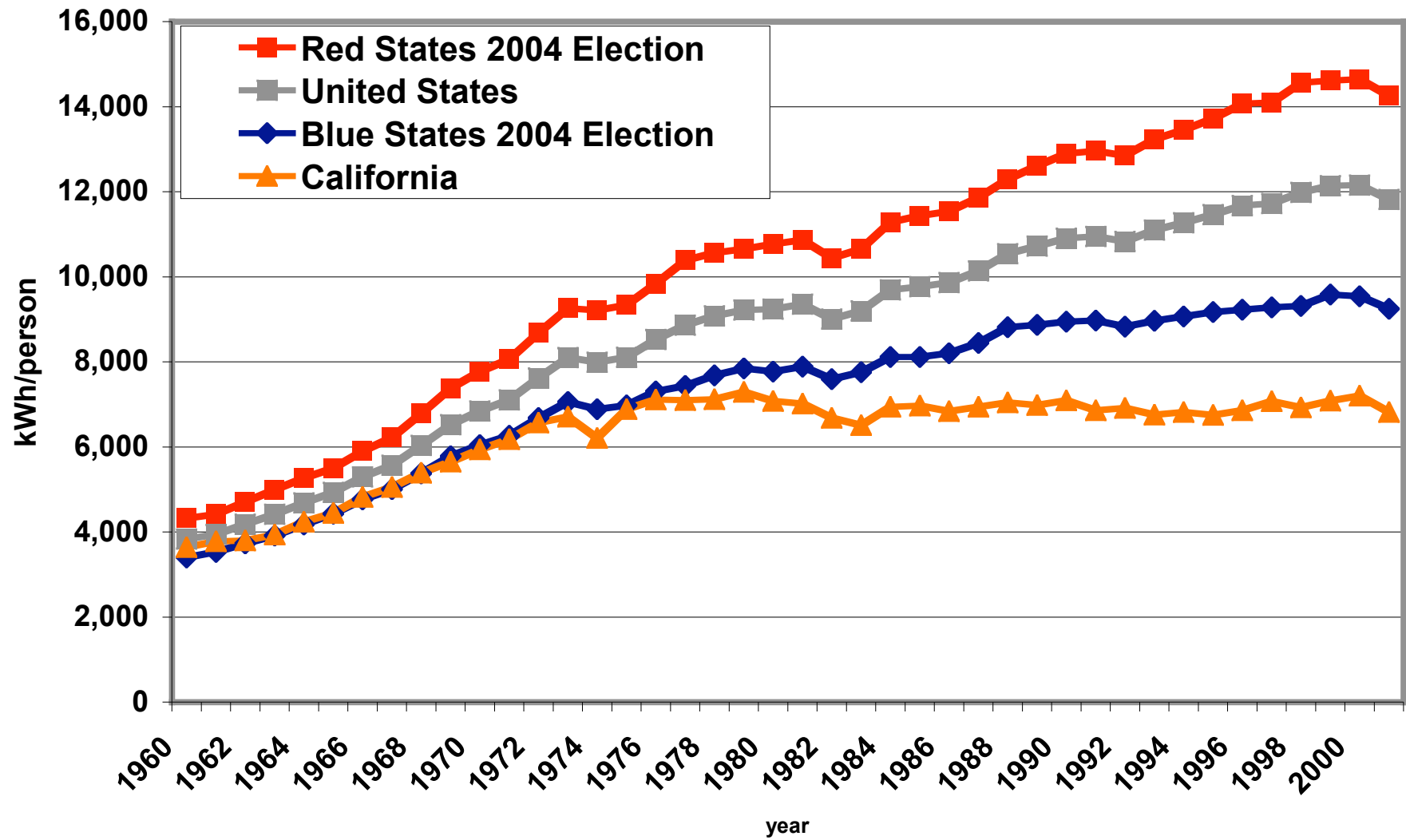
Carbon Dioxide Intensity and Per Capita CO2 Emissions -- 2001
(Fossil Fuel Combustion Only)

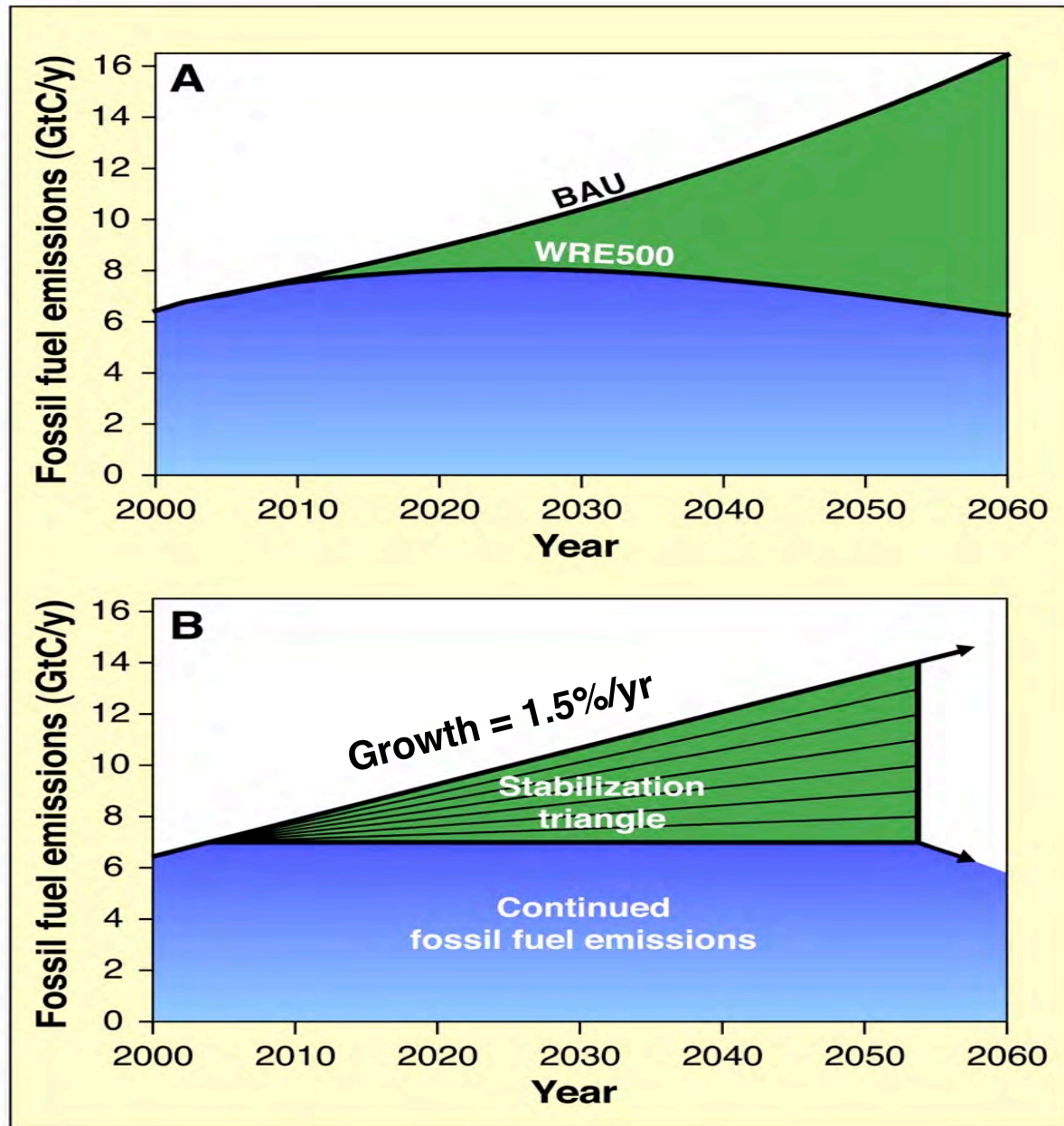


Carbon Dioxide Intensity and Per Capita CO2 Emissions -- 2001
(Fossil Fuel Combustion Only)

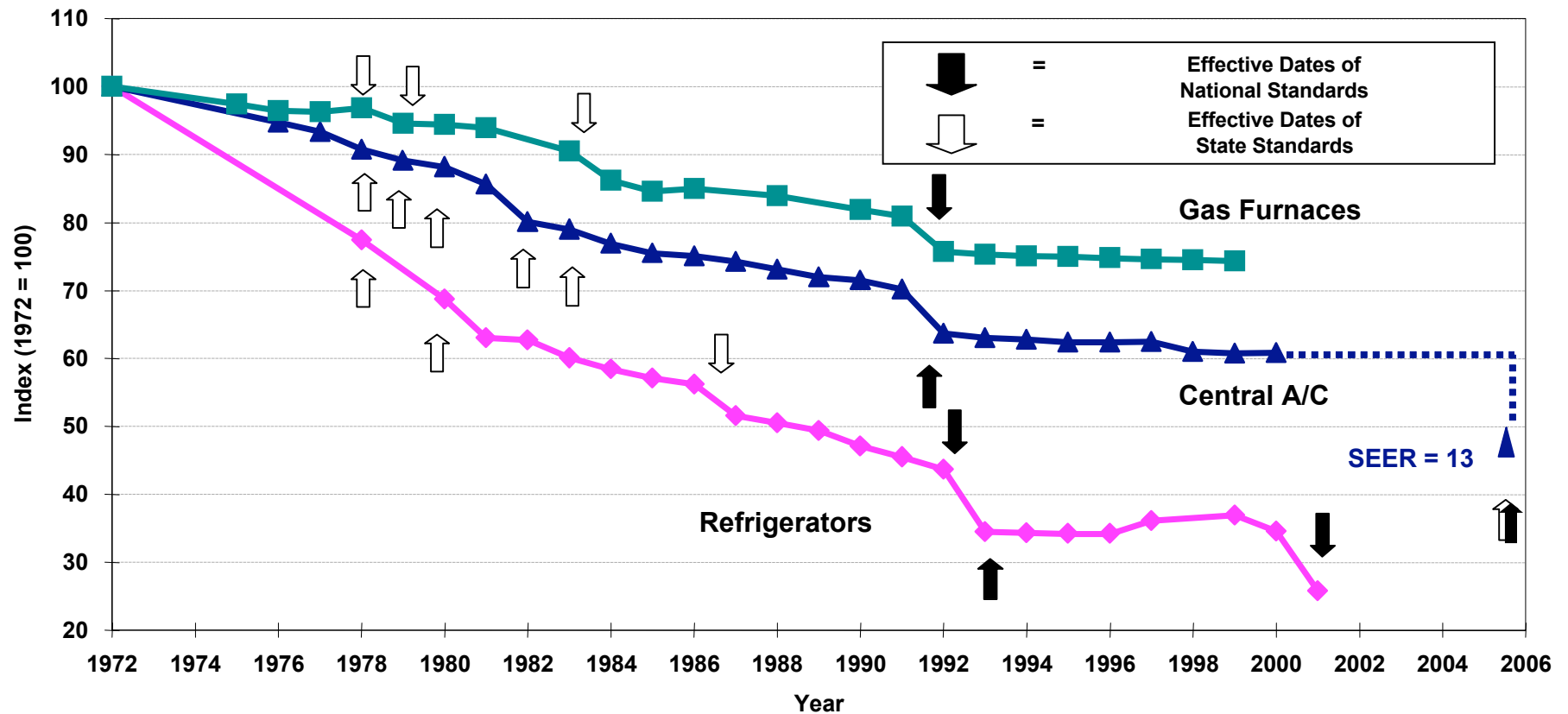


Per Capita Electricity Consumption



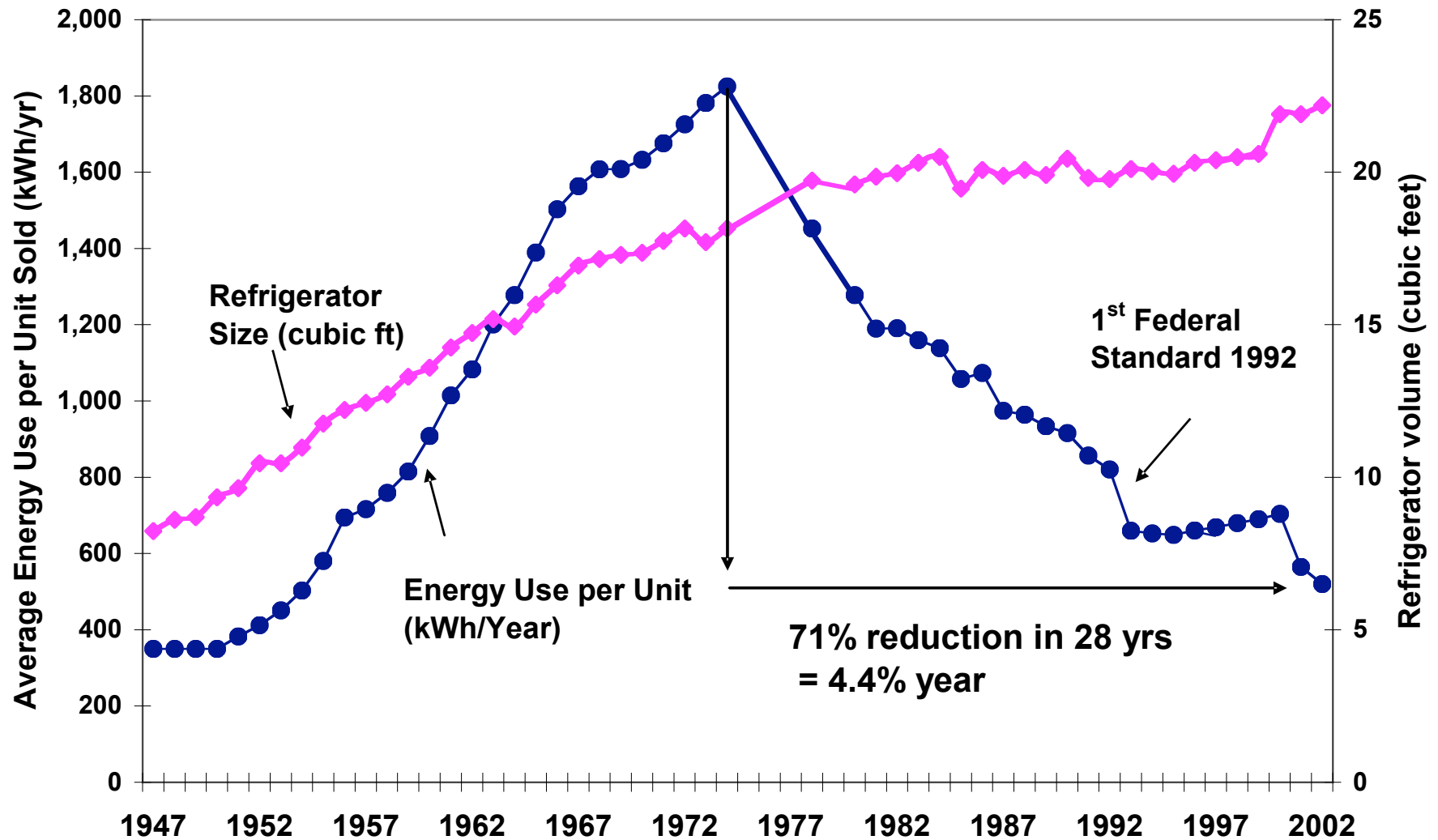


Impact of Standards on Efficiency of 3 Appliances

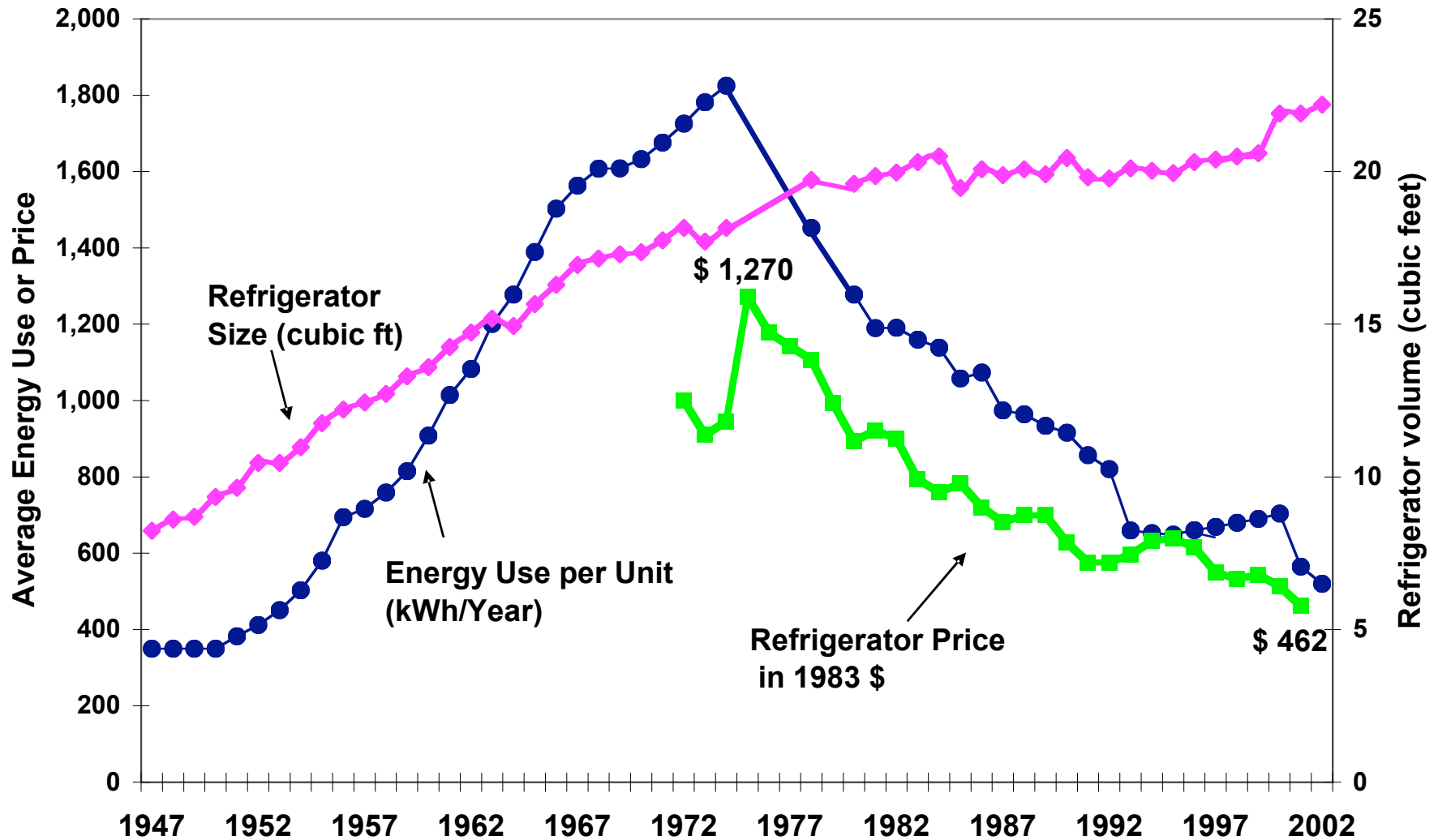


Source: S. Nadel, ACEEE,
in ECEEE 2003 Summer Study, www.eceee.org

New United States Refrigerator Use v. Time

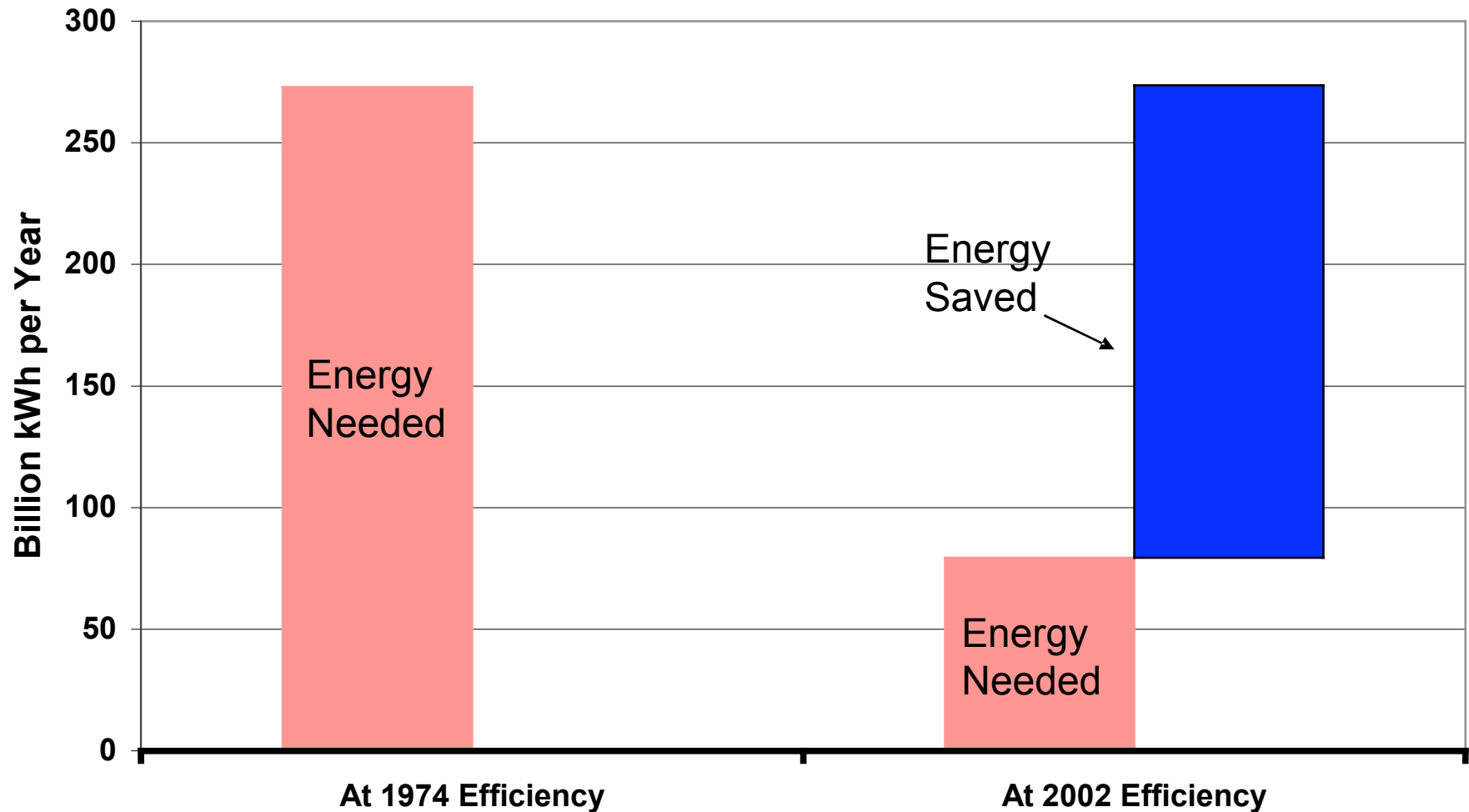


New United States Refrigerator Use v. Time and Retail Prices

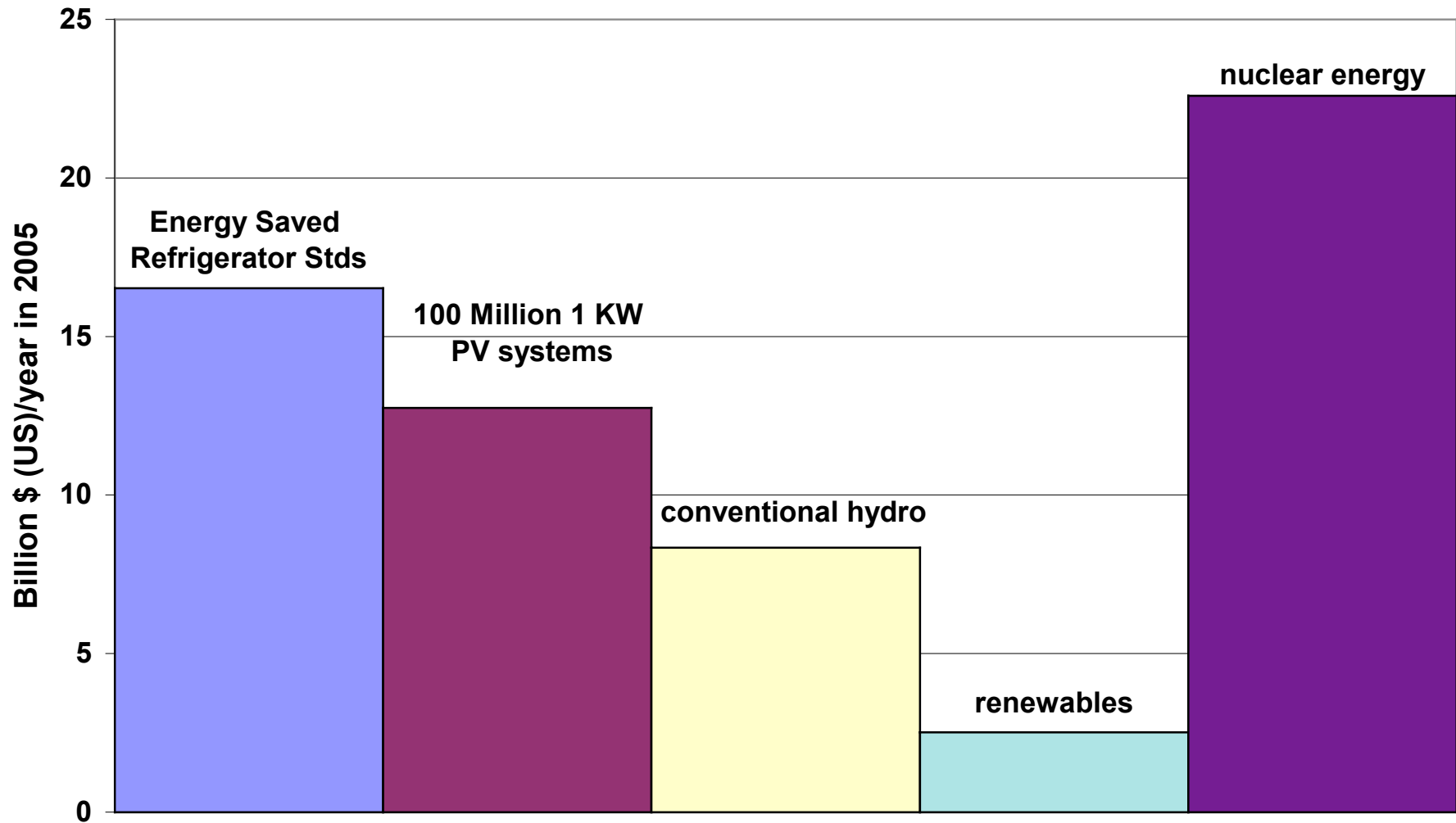


Source: David Goldstein

New Refrigerator Energy Use: 71% will be saved when stock completely turns over to 2001 Standards

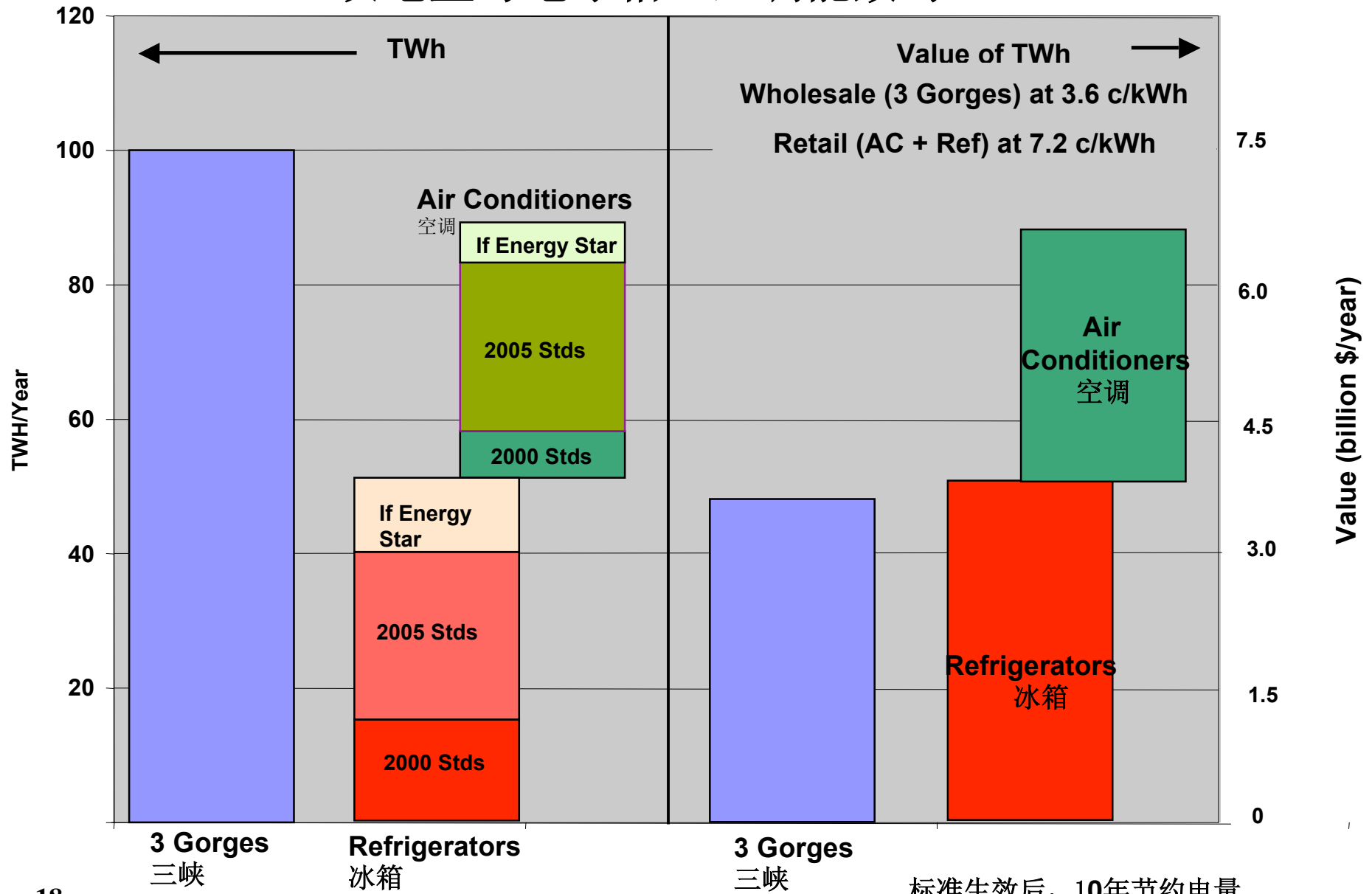


**Value of Energy to be Saved (at 8.5 cents/kWh, retail price) vs.
Several Sources of Supply in 2005 (at 3 cents/kWh, wholesale price)**

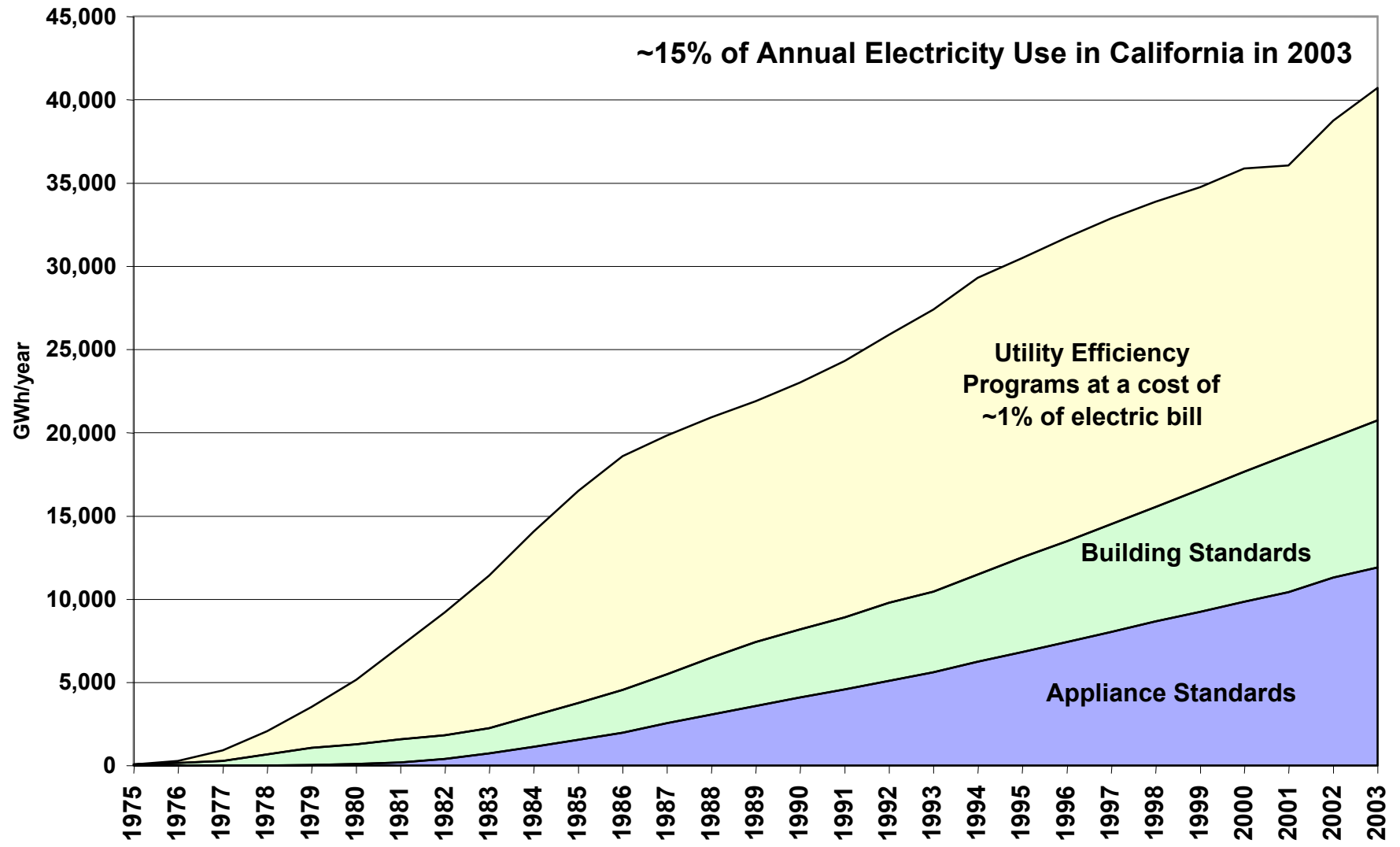


Comparison of 3 Gorges to Refrigerator and AC Efficiency Improvements

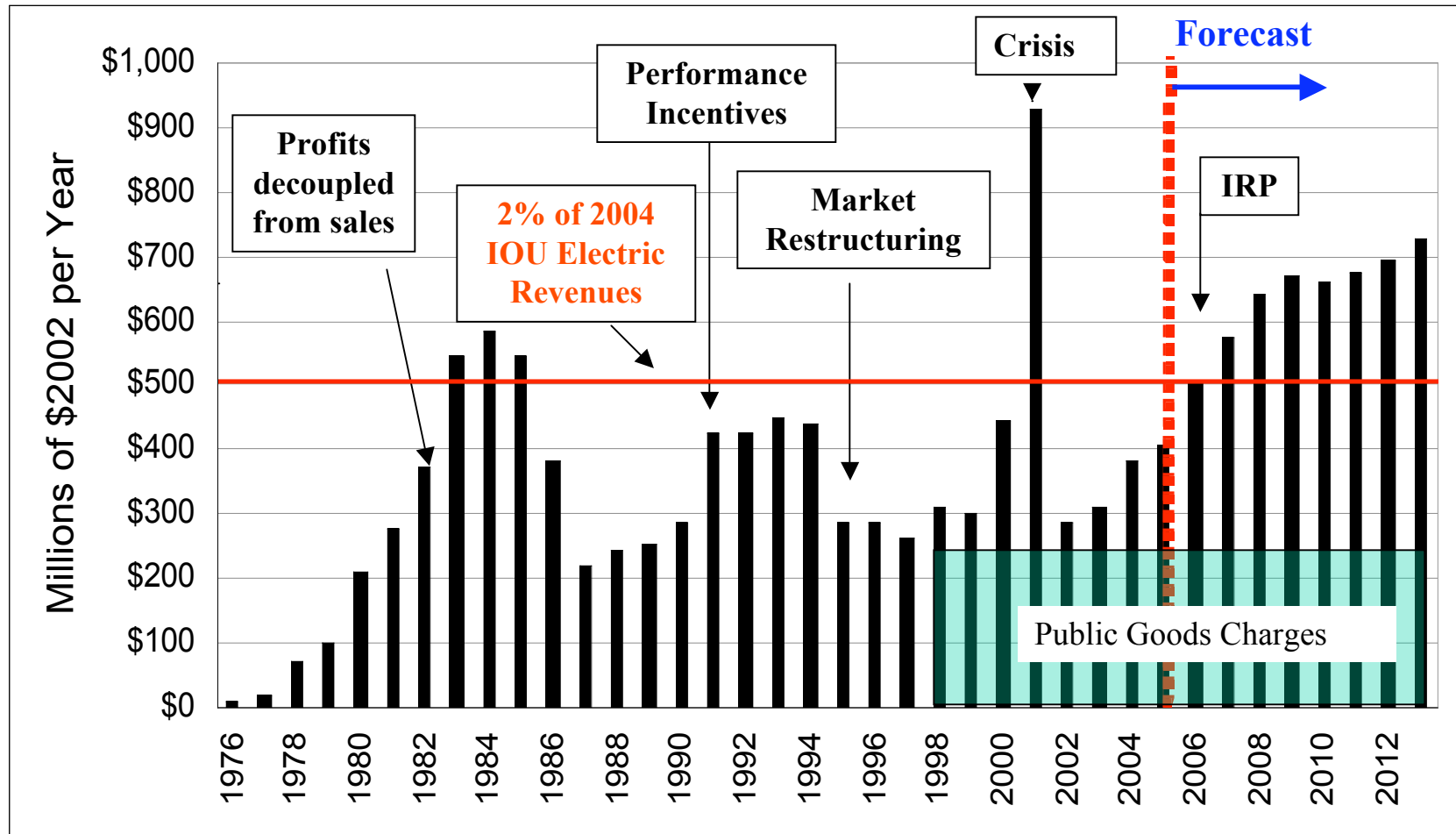
三峡电量与电冰箱、空调能效对比



Annual Energy Savings from Efficiency Programs and Standards



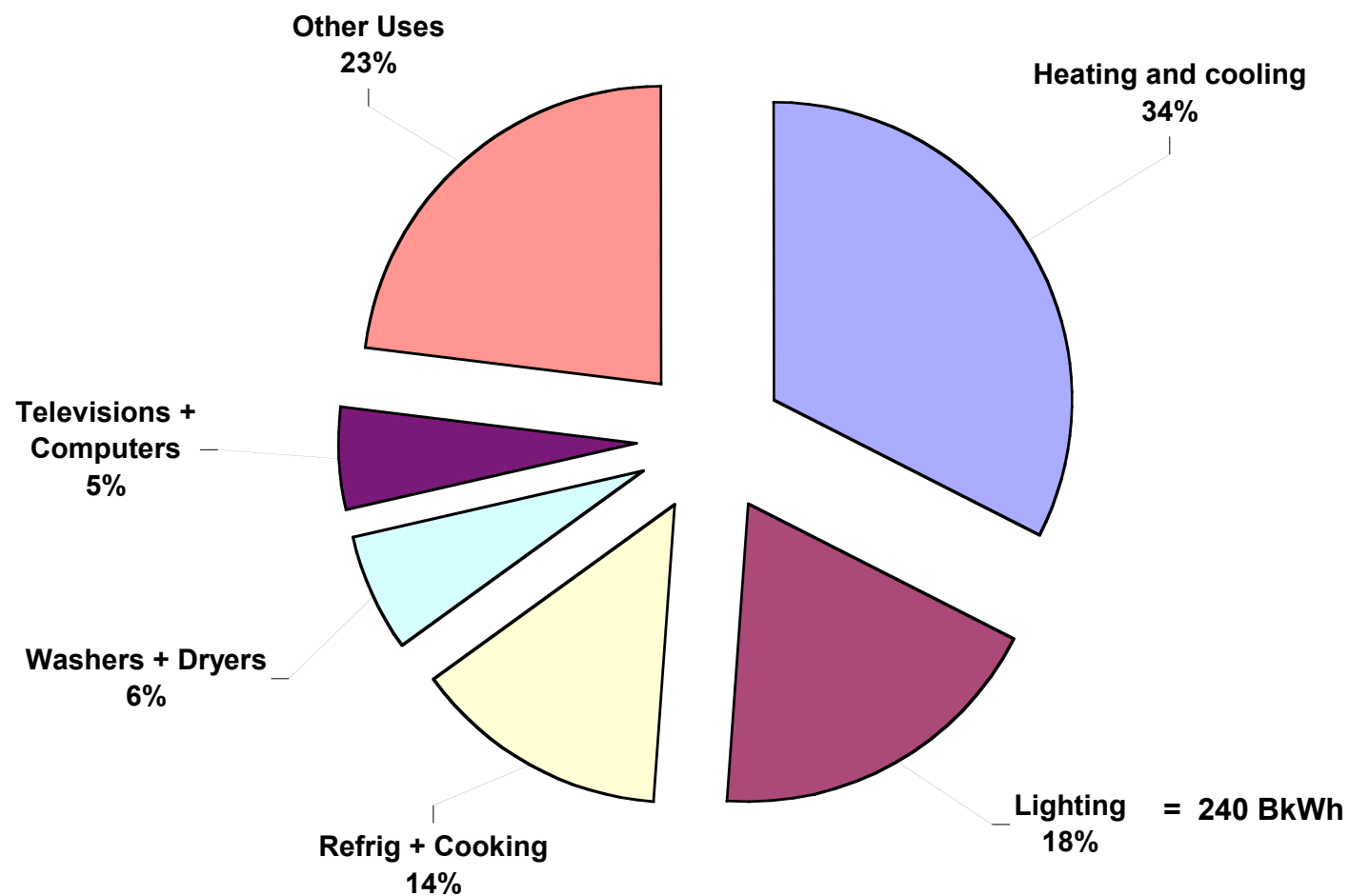
California IOU's Investment in Energy Efficiency



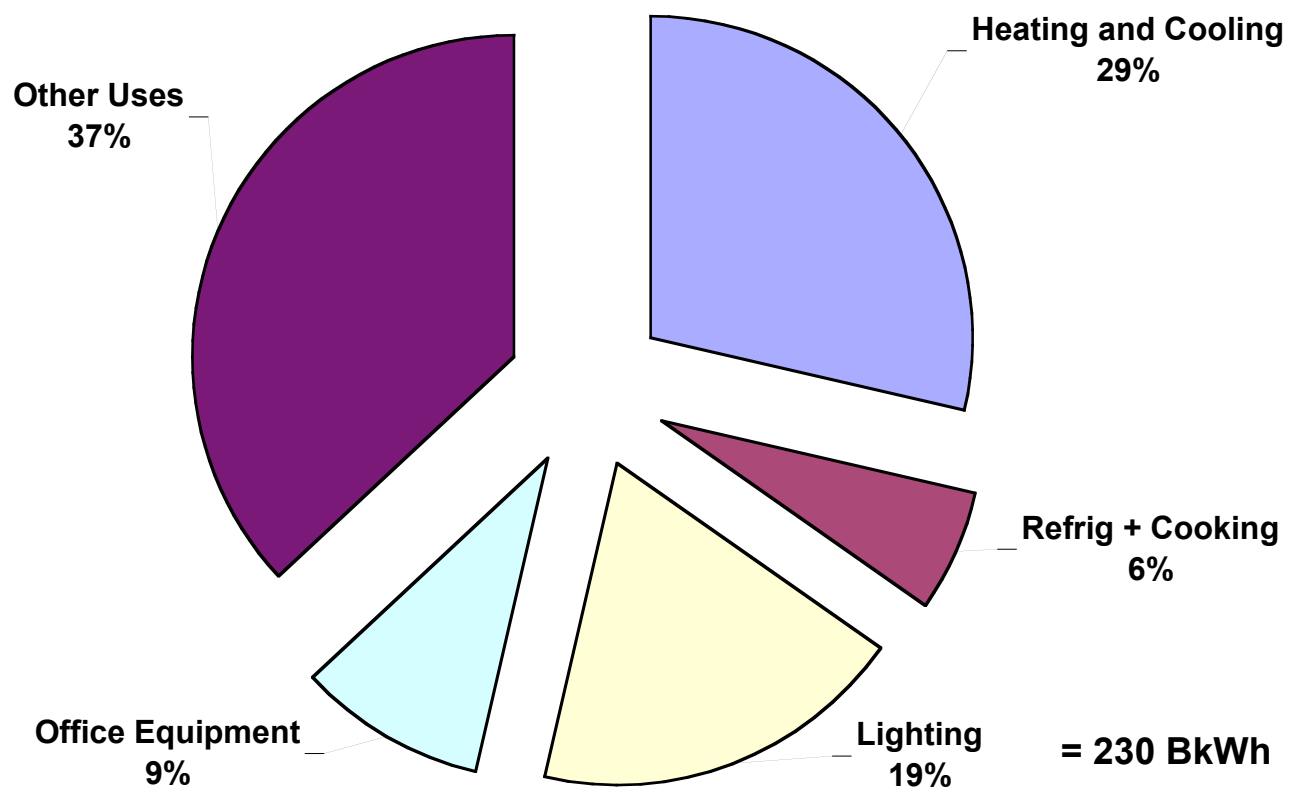
Now Turning Specifically to Lighting

- ◆ Lighting accounts for 6% of US energy use (2005 EIA Data)
- ◆ Or ~15 % of US electricity, see next slides.

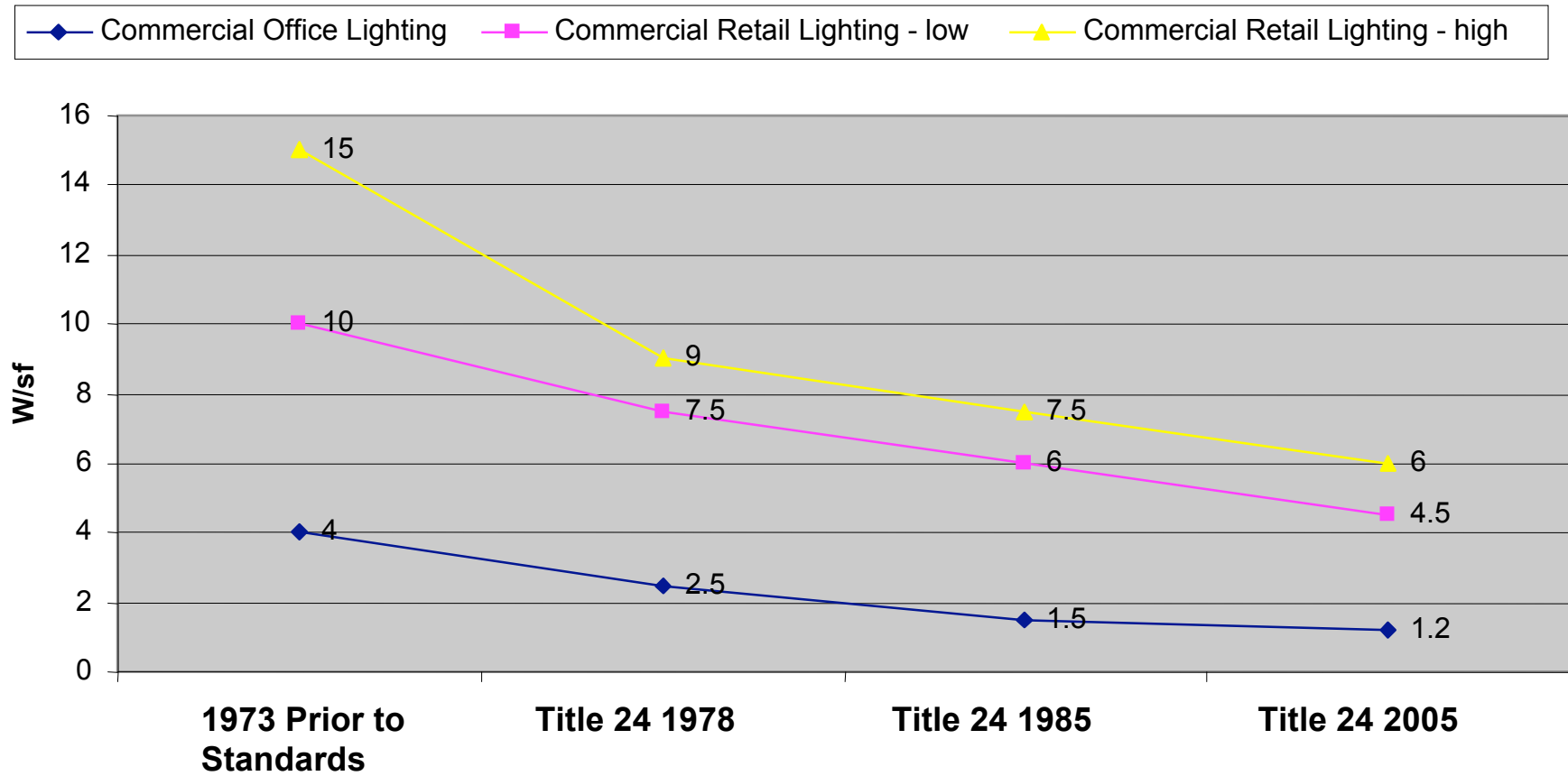
End Uses as Percent of Electricity In Residential Sector
US from Annual Energy Outlook
US Residential Sales = 1,300 BkWh



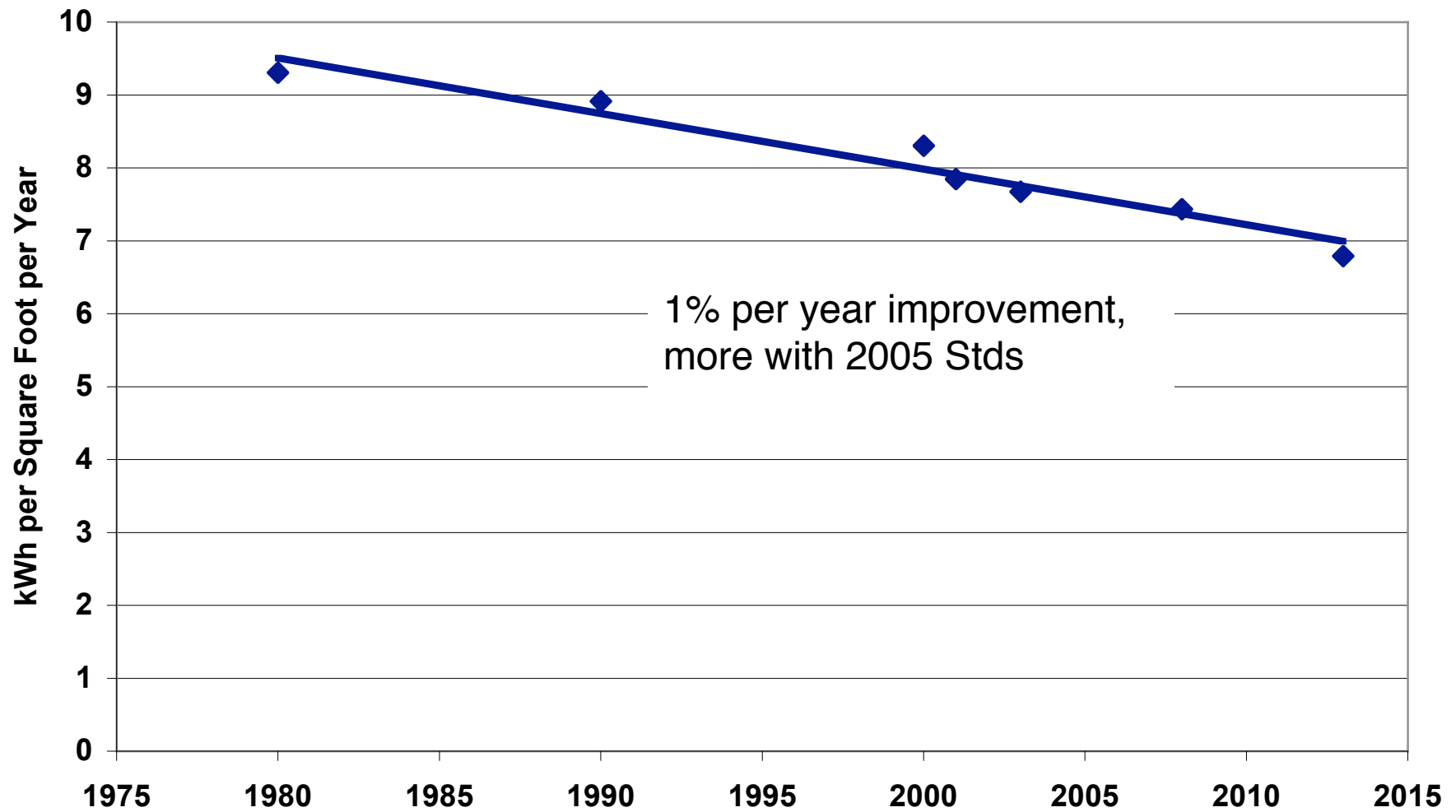
End Uses as Percent of Electricity In Commercial Sector
US from Annual Energy Outlook
US Commercial Sales = 1,230 BkWh



Commercial Lighting Power Density, New Buildings



Average Consumption for Indoor Lighting Large Commercial Office Buildings -- SCE (Std through 2001)



Title 24 Residential Lighting Impact

- ◆ Title 24 1978
 - ~ **5-10%** lighting energy use saved
- ◆ Title 24 1985
 - ~ **10-15%** of lighting energy use saved
- ◆ Title 24 2005
 - ~ **20%** of lighting energy use saved

CFL Costs

- ◆ Costs of CFLs have dropped....
- ◆ \$15 to \$25 from ~1982 to ~1995
(little change)
- ◆ \$3 to \$10 today

Reference: ESource Lighting Atlas, 2005

Electronic Ballast Costs

- ◆ Standard 2-lamp T8 Electronic Ballast
 - Early 1990's = \$35-\$40
 - Today = \$10 to \$15

Linear Fluorescent Costs

Table 7-6

Fluorescent lamp prices (1997)

These list prices are for four-foot lamps, based on case orders for GE lamps. Discounts below these prices are usually available.

Lamp type	Typical wholesale price per lamp (\$)
Energy saving 34W cool white T12	2.19
Energy saving high output cool white T12	9.17
Energy saving instant start cool white T12	10.27
70+ CRI T8	3.45
70+ CRI T12	4.39
80+ CRI T8	4.61
80+ CRI T12	9.74
Cathode out-put T12	4.80

“Standard” T8 lamp

In 1997 cost \$4.61

In 2003 cost \$2.44

Reference: ESource Lighting Atlas, 1997 & 2005

Table 7-6: Fluorescent lamp prices, 2003

The table lists prices for General Electric (GE) standard and premium 4-foot T8 and T12 fluorescent lamps

Lamp	Catalog ID	Power (watts)	Initial lumens	CRI	Lifetime, rapid start (hours)	Low-mercury TCLP compliant	Price ^a (\$)
GE F40 Watt-Miser	F34T12/CW/RS/WM	34	2,650	60	20,000	No	4.56
GE F40 Ecolux TCLP Compliant	F34T12/CW/RS/WM/ECO	34	2,650	60	20,000	Yes	1.38
GE F40 Ecolux TCLP Compliant	F34T12/SP35/RS/WM/ECO	34	2,750	73	20,000	Yes	2.99
GE F40 Ecolux TCLP Compliant	F34T12/SPX35/RS/WM/ECO	34	2,900	82	20,000	Yes	12.37
GE T12 HO Rapid Start	F48T12/CW/HO	60	4,050	60	12,000	No	7.99
GE T12 HO Rapid Start	F48T12/SP35/HO	60	4,250	70	12,000	No	14.63
GE T12 HO Rapid Start	F48T12/SPX35/HO	60	4,350	82	12,000	No	19.49
GE T12 VHO Rapid Start	F48T12/CD/1500	110	6,200	60	10,000	No	14.46
GE Starcoat	F32T8/SP35	32	2,950	78	20,000	No	1.82
GE Starcoat	F32T8/SPX35	32	2,950	86	20,000	No	2.40
GE Starcoat XL Extra-Life	F32T8/XL/SP35	32	2,950	78	24,000	No	2.30
GE Starcoat XL Extra-Life	F32T8/XL/SPX35	32	2,950	86	24,000	No	3.14
GE T8 Ecolux TCLP Compliant	F32T8/SP35/ECO	32	2,950	78	20,000	Yes	1.81
GE T8 Ecolux TCLP Compliant	F32T8/SPX35/ECO	32	2,950	86	20,000	Yes	2.44
GE T8 Ecolux XL Extra-Life	F32T8/XL/SP35/ECO	32	2,950	78	24,000	Yes	2.25
GE T8 Ecolux XL Extra-Life	F32T8/XL/SPX35/ECO	32	2,950	86	24,000	Yes	3.05
GE T8 Watt-Miser	F32T8/SP35/IS/WM/ECO	30	2,850	82	15,000 ^b	Yes	2.99
GE Watt-Miser XL	F32T8/XL/SP35/WM/ECO	30	2,800	82	20,000 ^b	Yes	3.81

Notes: CRI = color rendering index; TCLP = Toxicity Characteristics Leaching Procedure.

a. Prices are for T12 lamps in boxes of 10 and T8 lamps in boxes of 30.

b. These lamps are recommended for operation on instant-start electronic ballasts only.

Source: Platts; prices from GE Supply [19]

Title 20 (Appliance Efficiency Standards)

Savings from T-20 (2005), effective ~ 2007.

General Service Incandescent Lamps

- ◆ Saving 255 million kWh annually in California (5% energy savings)

Incandescent Reflector Lamps

- ◆ Saving 626 million kWh annually in California

Metal Halide Luminaires

- ◆ Saving 38 million kWh annually in California

**Total T-20 Lighting Saving: 0.9 BkWh/yr = 1/3
typical 500 MW plant**

Title 24 – 2005

(Building Energy Efficiency Standards)

Annual lighting energy savings, new construction:

	Percentage	GWh
Single Family	23.8%	55.5
Multi-Family	23.3%	9.1
Nonresidential	9.8%	84.1
Outdoor	25.1%	17.1
Signs	25%	2.7

**Total T-24 Lighting Annual Saving: 0.17 BkWh 1st year,
->1.7 BkWh 10th yr**

**Add T-20 + T-24 for 2.6 BkWh = 1 typical 500-MW power
plant**

Title 24 – 2008

Proposed lighting changes include the following:

- ◆ Residential Lighting
- ◆ Outdoor lighting
- ◆ Nonresidential indoor lighting
- ◆ Sign Lighting
- ◆ GU-24
- ◆ Hotel Key Cards (under review)

Next Workshop Date (tentative) December 6, 2006